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ABSTRACT

This document reports on research on the effects which the presence of other individuals have on another individual's performance. The experiment was conducted as follows: Selected male and female subjects were given the task of following a blind maze with a stylus. They were tested in performance under three different circumstances, alone, with a coactor, and with an observer. It was hypothesized that the presence of an observer (audience) or coactors would increase an individual's generalized drive which would enhance the emission of the most dominant motor response (either correct or incorrect). The distraction of intermittent noise was added during testing. The noise condition was surprisingly ineffective in producing an effect on performance. Relative to an alone-control condition, the social and physical stress conditions increased subjects' error rate during the incorrect-response phase and decreased errors during the correct-response phase of the experiment. The results of this study demonstrated the response pattern predicted by the hypothesis. A distinct difference between the sexes was noted, with women more significantly affected by coaction than men and making more errors under this condition. (JD)

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Habit Strength Differences in Motor Behavior:
The Effects of Social Facilitation Paradigms and Subject Sex
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Habit Strength Differences in Motor Behavior: The
Effects of Social Facilitation Paradigms and Subject Sex

The effects which the presence of other individuals have on another individual's performance has been termed social facilitation. Zajonc (1965) limited the social facilitation phenomenon to the audience and coaction paradigms. The audience paradigm involves spectators passively observing subjects' task performance and the coaction paradigm involves individuals performing simultaneously on separate but identical tasks.

In an attempt to integrate previously divergent social facilitation results, Zajonc proposed that social facilitation effects functioned in accord with the predictions of Hull-Spence (1956) Drive Theory. He hypothesized that the mere presence of audience members or coactors increased an individual's generalized drive (arousal) which enhanced the emission of the most dominant response at the time (either correct or incorrect). Therefore it was predicted that during initial task performance audiences and coactors had impairing effects on performance, but once the dominant response had changed from incorrect to predominantly correct they had a facilitating effect on performance.

Zajonc's (1965) hypothesis prompted much research which has recently been reviewed by Landers and McCullagh (1977). In spite of the rather wide acceptance of his explanation for social facilitation, there is a paucity of evidence for some important facets of his drive theory predictions. In his now classic review, Zajonc (1965) examined the audience and coaction paradigms separately, and concluded that both were derived from the Drive (D) x Habit (H) equals behavior (B) formulation. It is generally assumed that performance differences between these

paradigms may differ in intensity (D) relative to an alone control, but should not differ in direction. Perhaps because of the parsimonious nature of the hypothesis in accounting for these seemingly disparate performance situations, Zajonc's hypothesis has had great appeal to many investigators. Some of this appeal is diminished, however, since the assumed unidirectionality of audience and coaction effects has not been supported in the few studies that have directly compared these paradigms to an alone control.

Prior to 1965, only Dashiell's (1930) study directly compared coaction, competitive coaction (rivalry), audience and alone conditions on a number of tasks. Although Cottrell (1972, p. 191) summarized Dashiell's findings by suggesting that "the audience had the same effect as coaction," a more careful inspection of Dashiell's results reveal findings that contradict this interpretation. In four out of five comparisons (particularly measures of speed) his results for audience and coaction paradigms had opposite directional effects when compared to an alone control (cf. McCullagh & Landers, 1975). In addition, since the formation of Zajonc's hypothesis, other studies² have also failed to show the predicted unidirectional effects when audience and coaction paradigms have been examined in the same design. Audience presence was shown to enhance performance, but coaction was often found to depress performance relative to an alone control (Bird, 1973; Carment & Latchford, 1970; Dashiell, 1930). These directional differences suggest that other mechanisms besides D x H may be required in order to adequately explain social facilitation effects. A similar suggestion was made by Cottrell (1972, pp. 218-222) who maintained that variables other than those associated with the mere presence of coactors may produce directive

effects rather than the generalized effects assumed by Zajonc. These directive effects include imitation, changing nonsocial stimuli, and response-produced cues.

An alternative explanation for the incongruence of audience and coaction effects is that the tasks employed may not have been appropriate for examination of the drive-theory basis underlying these effects. Tasks for social facilitation research should meet the following criteria: (1) they should be sensitive to motivational changes; and (2) they should have a habit hierarchy that can be delineated. The latter criterion has been particularly problematic for motor tasks. Carron and Bennett (1976) have reviewed various methods for operationalizing the habit strength of motor tasks. They refer to habit hierarchy as the relative probability of occurrence of the correct versus the incorrect response(s) when there are a number of alternative, highly similar or identical responses for a particular task. It is generally recognized that habit becomes stronger through repetitive practice over trials. Carron and Bennett (1976) chose to operationalize habit strength for motor tasks by varying the frequency of one response alternative over another in a choice reaction-time paradigm (Carron & Bennett, 1976). Following practice under these conditions, subjects choice-reaction times were tested either on the same-response alternative (habit-correct condition), or a different-response alternative (habit-incorrect condition). In spite of their use of this habit-strength designation, Carron and Bennett were unable to find the predicted interaction between habit strength and performance in a coaction situation. This result may have been due in part to the experimenter's a priori determination of the number of trials needed to fully develop a dominant response without considering individual differences in habit formation. Although differences between

habit groups were found, there is no way of knowing how many of the individuals in each condition had actually formed their respective dominant response. The difficulty in knowing precisely when an individual has changed from a predominantly incorrect to a predominantly correct habit (at a presumed .50 probability level) may explain why reaction-time tasks have thus far been insensitive in eliciting social facilitation effects (Carron & Bennett, 1976; Wankel, 1972; Geller, Note 1).

A more promising task that meets both of the previously mentioned criteria is the complex-maze task³ developed and tested by Hunt and Hillery (1973, Experiment 2). For this maze there are four highly similar response alternatives at each level, only one of which is correct. Without seeing the maze, subjects must negotiate a pen-like stylus, through each level until they find the correct response to advance to the next level. Knowing in advance the range of total task-correct responses, the midpoint (e.g., 7.5) between the clearly identifiable range of possible errors (0-15) can be employed operationally as the point around which an incorrect habit becomes a predominantly correct-response alternative (i.e., $>.50$). The performance of each individual can then be examined both before and after their achievement of the criterion level. The training of subjects to a predetermined criterion level is not new in social facilitation research (Haas & Roberts, 1975; Martens, 1969). However, in these studies the criterion level was arbitrarily established since the investigators had no way of knowing the complete range of potential correct- and incorrect-task responses (i.e., floor and ceiling effects).

The purpose of the study was to examine the effects of habit strength in male and female performers within the social facilitation paradigms

of audience, coaction, and alone conditions. In addition, some subjects performed alone but with a known physical stressor (loud noise). This was done to contrast the effects of a known physical stressor with the psychological effects of the social facilitation paradigms. According to the social facilitation hypothesis the generalized drive (arousal) effects that result from physical and psychological stressors should conform to the same directional aspects of behavior, even though they may differ in intensity (Pessin, 1933). The resultant experimental design therefore was a $4 \times 2 \times 2$ factorial with four treatments conditions (audience, coaction, alone, and noise), two levels of habit strength (dominant correct, dominant incorrect) and two levels of sex. It was hypothesized that treatment conditions would interact with habit strength. Specifically, when compared to an alone-control group, subjects in the audience, coaction and noise conditions would perform better when the dominant response was correct and worse when it was incorrect.

Method

Subjects

Male and female college students were recruited from 15 physical activity classes in the physical education skills program. From the approximately 500 student volunteers completing the Eysenck Personality Inventory (1963), Spielberger, Gorsuch and Lushene (1970) State-trait Anxiety Inventory (STAI), and The Crowne-Marlowe Social Desirability Scale (1961), 144 subjects were selected based on whether their score on the Eysenck Personality Inventory (EPI) fell within the range 0-10 (introverts), 13-14 (ambiverts), and 17-24 (extroverts). Performance results based upon introversion-extroversion scores will not be presented in the present report.

Subjects were randomly assigned (36 per condition) to four treatment conditions (alone, audience, coaction, noise). In addition, care was taken to assign the same proportion (7:5) of males and females to each cell in the experimental design.

Approximately 10 subjects were eliminated from the subject population for failure to follow experimental instructions or inability to attain the performance-criterion level. Deviations from prescribed procedures were particularly evident in the alone condition where some subjects looked beyond the cloth-covered opening to solve the maze. Additional subjects were recruited following the above mentioned procedure to replace these subjects.

Apparatus and Materials

The experimental setting consisted of two cubicles, one control room and one test room, which were separated by a wall containing a 16 x 19.5 in. (40.64 x 49.53 cm) one-way observation window. The window was located at a level about 29 in. (73.66 cm) from the floor.

In the test room a small table was placed against the wall, just beneath the window. A wooden hood was installed in front of the one-way window on the surface of the table (See Figure 1). At the point nearest the wall the hood was almost ceiling height and extended 22 in. (55.88 cm) out from the wall. The hood was constructed with openings at three

Insert Figure 1 about here

places. It did not completely encircle the window, as the side of the hood farthest from the door and to the right of the seated subject was open from the table surface to the ceiling. This opening enabled an

observer (experimenter accomplice) to view the subject's task performance. The other two 6.5 x 14-in. (16.51 x 35.56 cm) openings at the base of the hood allowed the subject/coactor, when seated at the table in front of the hood to place his/her hands and forearms through the opening to the other side. The left opening allowed the subject to complete the motor task while the right allowed the coactor to perform the same action. Pieces of black cloth were attached to the front of the base openings allowing the subject (and coactor) to put his/her hand and forearm through the opening and at the same time block his/her view of the maze surface on the other side of the hood. Raised wooden blocks having a grooved channel were placed in the cloth openings to guide the subject to the starting position on the maze. While the subject could not view the maze path while performing, the experimenter in the control room on the other side of the one-way window had an unobstructed view of the subject's hand on the surface of the maze.

Two "complex-stylus mazes" (Hunt & Hillery, 1973) were anchored to the surface of the table behind the hood, about 5 in. (12.7 cm) inside the two openings (See Figure 2). A maze consisted of narrow .125-in.

Insert Figure 2 about here

(.3175 cm) wide pathways machined into the surface of a 10 x 13-in. (25.4 x 33.02 cm) piece of plexiglass to a depth of .125 in. Each maze had five levels with four alternatives at each level that were traversed by a stylus held in the hand like a pen. In drive theory terms (Hull, 1943; Spence, 1956), the dominant response on this maze was initially incorrect for each subject, the probability of a correct response being only .25 or less. The maximum number of errors per trial was 15 or three errors

on each of the five levels. Error counts in excess of 15 were reduced to this maximum value to discount duplicate errors caused by retracing. A score of 8-15 delimited the incorrect-response phase. Three consecutive trials of seven or fewer errors were required for correct-response phase classification. In addition, the performance-criterion level for task completion was three consecutive trials with no errors.

Two lights were mounted on the hood at eye level to the subject. An entry into a cul-de-sac while tracing closed an electric circuit which simultaneously illuminated a red light informing the subject of an incorrect response. When the subject finished the maze a white light simultaneously signalled completion of that trial and the beginning of a 20-sec intertrial period. The subject withdrew the stylus and returned it to the starting position during this time. The start of the next trial was signalled by the termination of the "finish" light. A Lafayette data systems programmer (Model 12800), input/output buffer (Model 922) and reader-punch system (Model 5411) were used to control the intertrial interval and automatically total errors for each trial. These error totals were automatically punch-recorded on paper tape. While the subject was completing the maze trials, the investigator monitored the time taken to complete each trial on a .001-sec Hunter Klockounter (Model 220C).

In the coaction treatment condition, a partition was placed between the subject and coactor seated to his/her right. While the partition allowed awareness of the coactor's presence, it prevented detection of his upper body movements, facial expressions and feedback lights.

Procedure

The following treatment conditions were experienced by the subjects:

Alone. When subjects arrived at the laboratory, they were seated in the testing room and were asked to complete a volunteer-subject consent form. Instructions were then played from an audiotape informing the subject that the task was to "learn the maze" (traverse it until three consecutive trials without error were attained). In addition, it was stressed that accuracy, not rate of traversing, was the criterion measure. The male experimenter then answered any questions and demonstrated the method of locating the starting point under the hood. The subject completed one practice trial (no score was recorded) during which time any deviations from the prescribed procedure were corrected.

At this point the experimenter left the testing room under the pretext of monitoring the automatic performance-recording devices located at the opposite end of the laboratory. The subject was asked to wait approximately 10 sec before beginning the task. To assure the subjects that they were not being observed, they were instructed to press a "dummy" signalling button placed alongside the block and inside the hood to recall the experimenter. In the other treatment conditions these procedures were modified in the following ways.

Coaction. For the coaction condition, an experimenter accomplice acted in the role of the coactor and was waiting to be tested when the subject entered the laboratory. Subjects were told that time and facility restrictions required both the subject and the coactor be tested at the same time with the partition in place to eliminate distracting influences. The coactor was always seated to the right of the subject, and both were told they should quietly concentrate and perform their own task.

Audience. For the audience condition, the subject was told that a "graduate student" (actually an experimenter accomplice) wished to quietly observe the task performance. The accomplice stayed behind the hood opening during the performance so his facial expressions were hidden.

Noise. Subjects were informed that the study concerned the effect of a "noisy environment" on performance. A tape recording, containing background white noise (i.e., variable whistle and buzzer sounds - 95 db. re 20 $\mu\text{N/m}^2$) was played continuously throughout the trial and intertrial intervals.

Following subjects' completion of the performance-criterion level, they were asked to complete two self-report measures, Spielberger et al. (1970) State form of the STAI and Thayer's (1967) Activation-Deactivation Adjective Checklist (AD-ACD). Finally, they were debriefed and given information on the nature of the study.

Results

Self-Report Measures

In an effort to determine if the treatment conditions affected any changes in the subject's situational anxiety level, two Sex x Treatment (2 x 4) ANOVAs were computed separately for the STAI and AD-ACL scores. No significant differences were found indicating that the three experimental conditions did not result in heightened levels of arousal compared to the alone-control condition.

Error Data

Errors were averaged over trials for each subject to arrive at one score for the incorrect-response phase and one score for the correct-response phase. A Sex x Treatment x Dominant Response (2 x 4 x 2) ANOVA with repeated measures on the last factor was computed. A significant

sex main effect was found, $F(2, 120) = 5.63, p < .05$. Overall, males ($M = 5.45$) had significantly fewer errors than females ($M = 6.08$).

Several significant findings for within-subjects data were observed. A significant dominant response main effect was found, $F(1, 120) = 666.75, p < .001$. This finding merely showed that subjects made fewer errors on later trials which indicated that the technique for differentiating between the incorrect- and correct-response phases was effective. In addition, a marginally significant Treatment x Dominant Response interaction was evident, $F(3, 120) = 2.12, p = .10$. As Figure 3 illustrates, this interaction was consistent with the drive theory prediction of more

Insert Figure 3 about here

errors under conditions of heightened arousal when the dominant response was an incorrect one. In this case, more errors were evident in the noise ($M = 8.99$), audience ($M = 9.81$), and coaction ($M = 9.60$) conditions than in the alone condition ($M = 8.39$). Results in the correct-response phase were reversed in direction, showing fewer average errors for the former three groups than the alone condition.

Trials to Criterion

The same analysis as used for the error data compared the number of trials subjects required to complete the incorrect-response phase (15-8 errors) and the correct-response phase (7-0 errors). A highly significant main effect for sex appeared, $F(1, 120) = 17.74, p < .01$, indicating that females ($M = 11.27$) required a greater number of trials for task completion than males ($M = 8.11$). All other between-subjects main effects and interactions were nonsignificant ($p > .05$).

Within-subjects analysis indicated a significant dominant response main effect, $F(1, 230) = 175.07, p < .001$. This revealed that a greater

number of trials was needed to complete the correct-response phase ($M = 13.76$) than the incorrect-response phase ($M = 5.09$). This is consistent with exponential growth curves that are frequently found for learning (Estes, 1956). In addition, a significant Sex \times Dominant Response interaction (See Figure 4) was found, $F(1, 120) = 6.44, p < .05$. Tests of the simple-main effects revealed significant differences in the correct-response phase, $F(1, 273) = 23.60, p < .01$. In this phase,

Insert Figure 4 about here

women ($M = 16.58$) performed significantly more trials to criterion than men ($M = 11.74$).

Discussion

The results of this study demonstrated the response pattern predicted by the social facilitation hypothesis (Figure 3). Relative to an alone-control condition, the social and physical stress conditions increased subjects' error rate during the incorrect-response phase and decreased errors during the correct-response phase. The most pronounced effect was the decrement experienced by subjects performing in coaction and audience conditions when the incorrect habit was dominant. The pattern of these findings showed for the first time that the effects of noise, audience and coaction are unidirectional with the audience condition producing the greatest intensity effects during both response phases.

The treatment conditions by habit strength interaction, (cf. Figure 3), however, only approached significance and the amount of variance accounted for was very low ($\omega^2 = .02$). The "strength" of these findings was not totally unexpected since by design the audience and coaction conditions represented "minimal social conditions" to test what Zajonc (Note 2) has termed "mere presence." By mere presence,

Zajonc was referring to performance effects that are due solely to the presence of others, rather than to the more powerful directive factors and processes (i.e., imitation, evaluation apprehension, competition, and reinforcement) commonly associated with the presence of others. The intensity of arousal is expected to be higher when directive and mere presence effects are combined. Further support for the minimal social conditions in the present experiment is provided by subjects' responses on the arousal measures. Subjects in the coaction and audience conditions ($M = 1.90$ -AD-ACL; $M = 39.0$ -STAI) reported only low to moderate levels of arousal in these situations. It is not known how these self-report arousal levels correspond to other studies that have similarly attempted to create mere presence effects with this task. The coaction condition, for example, may have been even less arousing than the coaction condition used by Hunt and Hillery (1973). Although this experiment primarily duplicated their test procedures, the studies differed in the number and spatial positioning of coactors. Hunt and Hillery had three coactors (none of whom were accomplices) seated equally spaced around a circular table where they could see each others' facial expressions. The use of three coactors may have enhanced their effects compared to the present results since there is some evidence which suggests that more than two coactors are needed to obtain the predicted social facilitation effects (Burwitz & Newell, 1972; Martens & Landers, 1969). Moreover, the positioning of coactors in Hunt and Hillery's Experiment 2 may have also contributed to their stronger findings since evidence indicates that this position is perceived as more competitive than the side-by-side position used in this study (Sommer, 1965).

The noise condition was surprisingly ineffective in producing greater arousal than alone conditions, as indicated by self-report arousal

measures. It may be that subjects became accustomed to the noise because it was not continuously variable. Pessin (1933) also investigated the comparative effects of physical and social stressors and found the physical stressor elicited greater effects than an audience condition. His manipulation, however, included both continuously variable noise and flashing lights. The combination of these distractions may be necessary in order to affect more profound performance changes.

There is no apparent explanation for the finding that women made more errors and had more trials to criterion than men. Carment (1970) and Hunt and Hillery (1973) found that males performed similarly in alone and coaction conditions whereas females were significantly affected by coaction. No support was found for this finding in the present study. Instead, males performed better than females regardless of treatment condition. Further research is necessary to determine if there is any underlying basis for these reported sex differences.

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Footnotes

¹Since the relative contributions of the second and third authors were equivalent, the order of their names was determined by the flip of a coin.

²Wankel (1972) investigated audience, coaction and rivalry effects in a factorial design employing simple and complex reaction times as dependent measures of performance. Unfortunately, the significant three-way interaction involving these paradigms are simply reported as uninterpretable. Wankel (1972) concluded that audience and coaction effects did not produce performance changes whereas rivalry significantly improved reaction time.

³Other investigators (Hunt & Hillery, Experiment 1, 1973; Shaver & Liebling, 1976; Williams, 1977) have used both a simple and complex mazes to examine correct and incorrect habits, respectively. Like the choice reaction-time paradigm, this procedure only approximates the habit strength of each individual without taking into account individual differences in rate of response acquisition.

Figure Captions

- Figure 1. Frontal view of hood (with partition for coaction condition).
- Figure 2. Five-level complex maze (adapted from Hunt & Hillery, 1973).
- Figure 3. Treatment condition by dominant response interaction for average errors.
- Figure 4. Sex by dominant response interaction for average number of trials to criterion.





